MODULAR BUILDING UNIT

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This invention relates to building construction and in particular to modular units for use in construction of buildings such as hotels, motels and hospitals.

a2> Traditional building materials include, bricks, concrete and cement. Timber is of course another traditional building material and buildings have been constructed using a timber frame work erected from panels formed by interconnected struts and cross-members.

Steel is another known building material which has been used to provide a framework for building units. Such units comprise rectangular parallelepiped steel frames formed from heavy duty structural members which support the floor and roof joists and wall studs.

Of recent years lightweight steel has been used for many applications in place of more traditional building materials. The known timber framework technology has been adopted with the panels formed from lightweight steel sections and comprising a frame of joists with cross runners, the frame being strengthened by lateral and/or diagonal bracing. Panels of similar construction but in other necessary shapes are also provided and the panels are transported to the intended location of the building. A floor is laid down first and the panels are then erected and connected on site to construct the building.

a3> Lightweight steel framing systems have a number of advantages. The first of these is the use of steel as a construction material. Steel, while having a relatively

construction material. Steel, while having a relatively high embodied energy content, is nevertheless a realistic incombustible structural alternative to wood. The use of steel also responds to the call by environmental organisations to minimise the use of wood in construction. Steel is 100% recyclable and has no material downgrading when recycled. There is little waste in its production and fabrication.

A further advantage of lightweight steel framing systems is that construction time can be reduced in comparison for example to constructions of brick and mortar. However on-site erection and interconnection of the panels is required and finishing of the building units including fitting of floor, roof and wall sheeting as well as decoration can only be done on site.

It is an object of the present invention to provide a unit module for a building which reduces the on-site construction time. It is a further object to provide such a unit which can be delivered to site in a fitted-out state.

It is a further object of the present invention to provide a building unit module which minimises the amount of steel required and is capable of fast construction whilst still being strong and robust.

It is a still further object of the present invention to provide a building unit module which can be formed at any desired length, width and height.

US Patent 3605350 describes a modular housing

structure which has an open-span interior, that is no interior load bearing walls. The structure comprises a base frame and a roof frame interconnected and spaced by corner posts. Two ends walls and side walls are formed from wooden studs with exterior sheeting.

WP Patent Application No. 2084213 describes a somewhat similar structure having a floor and a roof subframe connected together by vertical columns.

A building unit module comprising a lattice framework formed of a plurality of parallel rectangular frame members and multiple parallel runners connected to the frame members internally thereof, and sheeting attached to the runners to form an enclosure characterised in that the rectangular frame members are spaced along the length of the module, the runners each extending transversely along that length; in that the enclosure is defined exteriorally by the lattice framework, and in that the framework further comprises corner members extending lengthwise across the framework and connected to the frame members at the corners thereof.

The module is three-dimensional whereas the units of known lightweight steel framing systems are two-dimensional. This has a number of advantages. Firstly the amount of construction work on site is reduced as the need for erection and connection of individual panels of known lightweight steel framing systems is done away with. Furthermore the module can be fitted out off site

which allows production line techniques for fit-out and reduces the amount of materials and manpower required on site.

It has been found that the combination of the rectangular frame members, runners and sheeting produces a robust and strong structure more than capable of functioning as a room of a building. It is noted here that although the frame members are described as "rectangular", deviations from true rectangular shape are possible depending on desired room configuration.

The dimensions of the module can be simply varied by varying the number and/or dimensions of the frame members. This means that the module is very versatile and usable in a large number of different types of building.

In a preferred embodiment the frame members each comprise four interconnected frame sections. It is particularly preferred that the frame sections are joists of C-shaped cross-section and the runners are furring runners of "top hat" section.

In a first embodiment the frame members are formed first and the runners then connected thereto to provide the lattice framework. In an alternative embodiment, which is particularly suited for shipping overseas, spaced frame sections are interconnected by runners to form two panels and the ends of each frame section in one panel are connected to the ends of a frame section in the other panel by a pair of frame sections running

transversely to the planes of the panels to provide the lattice framework.

The corner members may be angle members of structural steel and may be provided internally and externally of the framework.

The ends of the modules may be provided with plural parallel cross runners extending widthwise and connected to the end most frame members. The ends of the module can therefore be closed off by securing sheeting to the cross runners.

The cross runners may mount at least one window frame at one end of the module and a door at the other end of the module. Alternatively or additionally window frames may be mounted in the main runners as too may be door frames.

The cross runners may be provided in the form of two prefabricated panels which are then connected to the endmost frame members. Each panel is fitted with a door or window sub assembly as required.

Very preferably the lattice framework is formed of light gauge steel structural sections. Thus the advantages of steel as a construction material are employed in the module but the module is still relatively light. The use of lightweight steel allows the module to be transported via trailer to the proposed building site and manoeuvred into position simply and safely.

Plural modules may be used to form a building in which the modules are stacked one atop the other and/or

positioned side by side and interconnected by connecting the lattice framework of each module to the lattice framework(s) of the or each adjacent module(s).

The invention also provides a method of constructing a building comprising forming plural rectangular frame members, positioning the frame members vertically and in alignment, connecting multiple horizontal runners to the frame members with the horizontal runners parallel to each other to form a lattice framework, and, securing sheeting to the lattice framework via the runners so as to form an enclosure, characterised in that three or more rectangular frame members are formed which are positioned in an aligned row with a first predetermined spacing between each adjacent pair of frame members; in that the runners are connected to the frame members with a second predetermined spacing between each adjacent pair of runners, and in that the method further comprises, prior to securing the sheeting, securing horizontal angle members to the internal and/or external corners of the lattice framework.

The method, which provides a module of the first embodiment, preferably includes securing horizontal angle members to the four internal and four external corners of the lattice framework and carrying out the frame member formation step by interconnecting four structural sections.

Brief Description of the drawings

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The invention will now be further described by way of example with reference to the accompanying drawings in

which:-

Figure 1 is a perspective view of a building unit module in accordance with the invention;

Figure 2 is a side view of the module of Figure 1;

Figures 3A and 3B are perspective views illustrating alternative constructions of frame members forming part of

the building unit module of Figure 1;

Figure 4 is an exploded perspective view illustrating a method of construction of the building unit module of Figure 1, and,

Figure 5 is a perspective view of three modules as shown in Figure 1 connected together in use.

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The module shown in Figures 1 and 2 comprises a series of rectangular frame members 4 which are termed hereinafter "ribs". The ribs 4 are made from standard structural steel sections, preferably stud joist sections, welded together. The length of the four stud joist sections forming each rib 4 determines the cross-sectional dimensions of the module 2. The length of the module 2 is determined by the number of ribs 4 used.

The ribs 4 are positioned vertically at a first predetermined spacing in two spaced jigs. Preferably one jig is fixed whilst the other is movable to accommodate ribs 4 of different width.

The ribs 4 are connected by a series of horizontally positioned runners 6 which run the full length of the module 2. The runners 6 are spaced at a second predetermined spacing and welded to the ribs 4 to create a lattice beam structure.

The ribs 4 are preferably constructed by welding four lightweight stud joist sections 5 together with two side frame sections 5a and a top and bottom frame section 5b. The stud joist sections employed may be of C-shaped cross-section with return flanges to give an overall open mouth box configuration. Other common sections can be used but preferred are the stud joist sections produced by the Applicants and described in their brochure Ayrshire Steel Framing. The preferred stud joist sections have cross-sectional dimensions ranging from 40 mm x 70 mm to 40 mm x 340 mm. The runners 6 are also preferably lightweight steel structural sections and most suitably top hat sections.

In the module of Figures 1 and 2 the stud joist sections 5 are arranged as illustrated in Figure 3A, with the side frame sections 5a oriented with their mouths outward. The top and bottom frame sections 5b are butt welded to the webs of the side frame sections 5a. The

arms of the top hat section runners 6 are also welded to the webs of the side frame sections 5a.

The stud joist sections 5 shown in Figure 3A have the advantage that they are asymmetrical with unequal return flange sizes and so may be nested together to form a closed box for use at concentrated load points.

In an alternative arrangement illustrated in Figure 3B, the orientation of the side frame sections 5a is reversed so that the mouths are inward. In addition, the side frame sections 5a are made symmetrical with identical return flanges sized to receive a top or bottom frame section 5b therebetween with the top or bottom frame sections 5b then being welded to the inner side of the web of the side frame sections 5a. The arms of top hat section runners 6 are folded to the return flanges of the side frame sections 5a.

The advantage of the arrangement of Figure 3B is that the stiffness of the sides of the module 2, in particular the stiffness of the side frame sections 5a, is increased.

In addition to the ribs 4 and runners 6, the module 2 includes four steel angles 10 which run the full length of the module assembly and are welded to the four internal corners as well as a further four steel angles 12 which again run the full length of the module 2 but are welded to the four external corners.

An alternative method for constructing the module 2 is illustrated in Figure 4. Instead of forming the ribs 4 first and then connecting these with the runners 6, side

panels 14 are built from the side frame sections 5a and the runners 6. The module 2 is then constructed by welding the top and bottom frame sections 5b between the panels 14 to form, with the side frame sections 5a, the ribs 4. This method is particularly suitable for shipment overseas, since the panels 14 and top and bottom frame sections 5b can be shipped and then the module 2 built in the country where it is to be used.

Which ever construction method is used, the module 2 is completed by closing off the ends with struts 16 and cross runners 18 which may suitably be provided as prefabricated end panels 20 and securing roof and floor decking 20, 22 to, respectively, the top and bottom frame sections 5b. The walls are then skinned inside and out. The roof and floor decking 20, 22 are preferably secured by self-drilling, self-tapping screws as too may be the wall skins.

Figure 5 illustrates three modules 2 with those on the left in the sense of the Figure fitted with roof and floor decking 20, 22. As Figure 5 illustrates the modules 2 can be stacked one on top of each other and/or side by side to form a building.

The prefabricated panels 20 which close the ends of the modules generally act as window and corridor walls in a structure formed from multiple modules. Therefore one is provided with a door frame 24 and the other with one or more window frames 26. As illustrated in Figure 5, one or both sides of the modules 2 may be provided with a door

frame 24, either to provide communication to an adjacent module or, in the case of an end module, to provide external access such as to a fire escape. The door frames 24 are preferably provided as prefabricated sub assemblies. The window frames 26 are formed as part of the construction of the end panels 20.

The basic form of a module 2 can be modified in a number of ways. Internal partitions can be used to separate off an area to form, for example, a bathroom. Partitions may be formed from light gauge steel studs with single layers of plaster board having sound deadening quilt therebetween.

Another possible variation is to provide a "cut-out" from the overall rectangular shape of the module 2 which will act as a service duct. A cut-out is illustrated in the left-hand most corner of the module 2 of Figure 1.

Short lateral bracing runners 28 may be provided in the roof and floor of a module 2 to stop twisting of the top and bottom frame sections 5b.

The module 2, by virtue of its formation from lightweight structural steel sections, can be lifted and transported to a building site by trailer. For this purpose the upper external angle members 12 have lifting plates 30 welded thereto.

The first predetermined spacing, between the ribs 4, is suitably 400 mm but may be between 100 mm and 600 mm. In practice the spacing may be set by the dimensions of the floor decking, the distance between the ribs 4 being

adjusted according to decking side to produce a floor of desired stiffness.

The second predetermined spacing, between the runners 6, is preferably 500 mm but may be between 300 and 600. In practice again the spacing may be determined by the dimensions of the sheeting panels used on the walls of the module 2, in this case to give a desired wall stiffness. Standard panel sizes are 600 x 2400 mm.

The module 2 may have overall dimensions of 3m by 4m by 8m to allow two modules 2 to be transported on a standard trailer. However as will be appreciated the dimensions can be varied simply by varying the size and number of the ribs 4.

Many types of roof and floor decking are known as well as sheeting suitable for skinning to the walls of the module 2. Possibilities include Cement Bonded Particle Board (CBPB); Plywood; and Chipboard and Glass Reinforced Cement (GRC) as the decking and Plasterboard; CBPB and GRC as the sheeting. Currently preferred for the floor decking is tongue and groove, cement bonded particle board and bituminous-coated oriented strand board for the roof decking which is taped and sealed to render it waterproof. The external skins may be bitumen impregnated fibreboard, whilst the internal skin may be double layers of Plasterboard which may also be used to provide a sealing. Soundproofing materials such as sound deadening quilt is provided between the external and internal skins.

On site, plural modules 2 are positioned on to steel

foundations 32 as illustrated by Figure 5. They are joined one to another either with plates at the conjunction of four modules 2 and/or by connection with corridor floor frame assemblies. The modules 2 may be physically connected to the foundations but this is not always necessary.

The welding of the components of the module 2 may be mineral, inert gas (MIG) welding although other known types of welding can be used.

The modules 2 can be fitted out prior to delivery to site. A particular advantage of the module 2 is that the walls, floor and ceiling are particularly flat which is important when furniture is to be fitted.

The modules 2 are suitable for use in construction of any building which has a cellular or repetitive type layout with vertical alignment of load bearing walls. The modules 2 enable very rapid construction, typically 35% faster than masonry construction.